Georgetown Steam Plant
King County Airport
Seattle
King County
Washington

HAER No. WA-1

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Historic American Engineering Record
National Park Service
Department of the Interior
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HAER
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HISTORIC AMERICAN ENGINEERING RECORD

Georgetown Steam Plant

WA-1

Location:	Northeast corner of King County Airport Seattle King County Washington
Date of Construction:	1906-08, 1917
Engineers:	Stone and Webster Construction Co., with Frank B. Gilbreath, consultant
Owner:	Seattle City Light City Light Building Third Avenue Seattle, Washington
Significance:	The Georgetown Steam Plant is an early reinforced concrete structure housing America's last operable examples of the "first generation" of large scale, vertical steam turbine electric generators. It is also significant as an early example of "fast track" construction advocated by Frank B. Gilbreath.
Historians:	Steve Lubar, Flo Lenty and T. Allan Comp, 1979-84
Transmitted by:	Donald C. Jackson and Kevin Murphy, 1984

ARCHITECTURAL AND PHYSICAL DESCRIPTION:

The Georgetown Steamplant, constructed in 1906, is a significant example of Neo-Classical Revival architecture. This particular style, introduced in the United States in the 1890s, served as a model for numerous Federal, municipal and industrial structures across the country. The plant has a T-shaped plan and is constructed of reinforced concrete. The building is divided into two main wings, the Engine House and the Boiler House.

The front facade (west facade) of the Engine House is divided into three bays, the central predominating in architectural detail and scale. In the center is cast the construction date of the building "1906". The north elevation of the Engine House is divided into five bays by vertical masonry members, proportioned to simulate pilasters. Crowning the top is a masonry cornice. The simplicity of design here suggests the mass and weight element, characteristic of Neo-Classical Revival architecture. On the roof is a clerestory, comprised of casement windows, spanning the entire length of the north elevation, interrupted by a single monitor wing or outbuilding.

The Boiler House consists of nine bays spanning the front, (west elevation) comprised of sash windows and separated by masonry grids. The wing is four stories in height with a clerestory spanning the full length of the roof, interrupted by four recesses. The conical symmetry of the later-added stacks is the only interruption of the overall linear design of the building.

In terms of operating efficiency, the plant is very precisely organized. Its longest wing is devoted almost entirely to the production of steam. Before conversion to oil fired boilers, this wing consisted of four levels each with a separate function. At the top level was the conveyor floor for bringing coal into the building. There the coal was dumped form a continuous moving belt into eight funnel-shaped bunkers on the floor below. Each bunker stoked a pair of immense 932 H.P. Sterling water tube boiler Smoke flues extended along both sides of the coal bunkers directly above the boilers for carrying smoke to a fan-assisted rooftop stack.

On the second floor, the sixteen boilers were separated into two banks facing each other across a corridor that ran the full length of the wing. From the corridor each boiler could be inspected and maintained. On the ground level, below both rows of boilers, there was an ash car that rolled on rails set in the floor. Each car consisted of a dumping hopper that could be moved from boiler to boiler where it would collect ash waste for removal from the building. The entire coal and ash handling system within the building was arranged to allow the fuel and waste material to be simply dumped as necessary from one floor to the next without relying upon further mechanical distribution.

Oriented on a perpendicular axis across one end of the boiler wing, the second, shorter wing is devoted to generating electricity. The engine room, includes the three turbo-generators each with a circulating pump, a vacuum pump, and a barometric or jet condenser. The vertical generators are interconnected by a system of catwalks and ladders, and the condenser and steam piping are arranged between the generators and the wall. A raised platform at the second floor level is provided for the horizontal generator, and the condenser for this machine is located in the space directly below it.

Above the generators the engine room is open to the roof. A 50-ton crane runs on a track overhead to assist with disassembling the equipment for maintenance. Across from the generators on the opposite wall, the room is divided into a gallery with five levels. The lower floor is occupied by a bank of transformers and two exciters (small DC generators necessary to energize field windings in the turbo-generators to produce the basic electromagnetic force). Above this section at various levels are the plant office, the switchboard room, and other control equipment. The 10,000 KW horizontal generator and its condenser are simpler and more compact than the two older vertical machines. It is smaller even than the 3,000 KW unit which has less than one-third its generating capacity. The vertical configuration requires the use of a step bearing to carry the tremendous weight of the revolving mass. The bearing actually floats the shaft on a thin layer of oil that is constantly injected by high pressure pumps.

The Georgetown Steam Plant has undergone very little modernization since the installation of its third generator in 1917. The boilers were converted to steam atomized oil furnaces beginning in 1918 and the process of conversion continued until 1946. This modification was accomplished without requiring any substantial alterations to the building, although the coal conveyor and ash cars were removed. When the King County Airport was constructed on adjoining property in the mid-1930's, it became necessary to replace the tall exhaust stack with roof mounted induced draft fans to prevent the stack from interfering with the flight path. Both original smoke flues were dismantled, and new ducts were installed to connect into the system of fans.

The plant was originally built on the east bank of the Duwamish River to take advantage of the river as a source of cooling water for the condensers and for convenience in discharging wastewater. At roughly the same time the stack was removed the Duwamish was diverted to accommodate construction of the county airport, leaving the plant some distance from the river's new channel. A pumping station was therefore built to insure a continued supply of river water, and the discharge tunnel was also lengthened. Finally, the original barometric condensers for the two vertical generators were rebuilt in 1965 and 1969. Both new condensers are in general duplications of the earlier installation as is apparent from the engineer's drawings on file.

GEORGETOWN STEAMPLANT HISTORY AND SIGNIFICANCE

I. General Electric, Westinghouse and Urban Electrification

In 1882, Thomas Edison opened his Pearl Street Plant in New York City to initiate the Electrical Age in urban America. While advocates debated the relative merits of direct and alternating current, eventually settling on the latter, reciprocating steam engines driving a separate electrical generator appeared from coast to coast. As demand for electricity increased, companies tried to increase both the size and number of generating units, but were beginning to encounter limits on engine/generator size as well as station size. In an early attempt to alleviate this threat, the Westinghouse Company secured the patents to the Parsons steam turbine (patented 1884), the first successful industrial turbine, much smaller than equal engine/generator units, even if no more efficient. For nearly a decade, Westinghouse clearly had the upper hand. The growth of central generating stations required increases in capacity and the massive engine/generator units with their vibration limits and size requirements could not meet that demand. Westinghouse had the only operating turbine on the market.

Charles G. Curtis (1860-1953) received patents 566,967, 566,968, and 566,969, protecting the basic principles of the Curtis turbine, in September, 1896. These patents cover, respectively, the expansion nozzles and their regulation, the concept of velocity compounding, and the concept of pressure compounding. Curtis assigned all three patents to his own company, the Curtis Company, which one year later entered into a liscensing agreement with the General Electric Company. For $1,500,000, General Electric received rights to all uses of the Curtis turbine except aerial and marine propulsion.[1]

General Electric formed a new division to undertake the development and manufacture of the Curtis turbine. From 1897 to 1902, General Electric built and tested a variety of designs based on the Curtis patents. Until 1900, Charles Curtis himself directed this research.[2] In 1901, William Le Roy Emmet took charge of the development of the Curtis turbine. Emmet (1858-1941), a central figure in General Electric's development of prime movers, trained at the U.S. Naval Academy and worked at various jobs in the electrical industry before he joined the new General Electric in 1892. General Electric, concerned by the lack of progress with the Curtis turbine project offered Emmet charge of the turbine project at a point when it was considering dropping it. Emmet realized the difficulties but thought the work extremely important and urged that it be allowed to proceed. In his autobiography he noted his overall impression of the work: "I think it is safe to say that there have not been many jobs more extensive and strenuous in the art of engineering." (Emmet 1931, p. 142)

Emmet directed the Curtis turbine project for twelve years, until 1913. Many of the features of the machine were incorporated as a result of his guidance, including the vertical orientation of the larger sizes. Emmet invented the oil-supported step bearing used to test the generators installed at Niagara Falls and made use of them in the Curtis turbine. He was also responsible for the selection of the sizes of the turbine, and for meeting the deadline for the delivery of the first machines. (Emmet 1931, p. 147)

Between 1897 and 1902, General Electric made a number of small turbines based on Curtis's principles. These were used for tests. The first placed in operation was a 500 KW unit installed at the General Electric plant in Schenectady in November, 1901. (Robinson 1937, pp. 239-240) The first vertical turbine to be placed in commercial service, a 500 KW machine, was shipped in February 1903 to the Newport and Fall River Company of Newport, Rhode Island. The first large Curtis turbine, and the machine which demonstrated the working feasibility of the design, was the 5,000 KW turbogenerator installed in the Fisk Street Generating Station of the Commonwealth Electric Company of Chicago in 1903. This turbine, removed to the Turbo-Generator Development Laboratory of General Electric's Schenectady plant, was designated a National Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers in 1975. The Fisk Street Station was the first power house designed specifically for vertical turbogenerators; room was allowed, though, should the unit have to be replaced by the more traditional reciprocating engine. (A.S.M.E. 1975, p. 4)

The Curtis turbogenerator was quickly successful. In the first fifteen months of sales, ending in 1903, General Electric sold 225,000 H.P. of Curtis turbines. (Westinghouse, by comparison, had sold some 300,000 H.P. of Parsons turbines for land use, and 83,000 H.P. for marine use, in the previous twelve years.) By June 1905, there were 224 units of the "larger sizes" in operation, totaling 350,000 H.P., including ten 5,000 KW machines. (Robinson 1937, pp. 241-242; G.E. Pamphlet 1907, p. 5) By September of 1906, Charles B. Burleigh reported to the National Association of Cotton Manufacturers "more than twice as many Curtis turbines in commercial operation in this country as there are of any other manufacture and more than the number of horse power of vertical shaft turbines in this country than there are of horizontal shaft turbines of all other manufacture . . ." (Burleigh 1906, p. 40) In three years of manufacture, the Curtis machine demonstrated its capacity as a cheap, compact, powerful, and efficient prime mover for electrical generation.[3] The design won the only grand prize for steam turbines at the St. Louis Exposition of 1904 and a gold medal at the Lewis and Clark Exposition in Oregon in 1905. (Burleigh 1906, p. 28)

Reasons for the superiority of the Curtis vertical steam turbine were often cited in long lists published by General Electric. Most often, these and other commentators focused on four major points: efficiency at all loads, simplicity, low maintenance, and economy in space. (G.E. Pamphlet 1907, p. 5) To this should be added the dramatic improvements achieved by General Electric during the decade of the 1900s. The Curtis units were significantly more efficient because they used both velocity and pressure compounding, because they did not require converting reciprocating motion to rotary motion, and because of a unique method of governing or maintaining speed under varying loads.[4] The most important reason for its efficiency, explained an article in the General Electric Review, was the combination of pressure and velocity compounding to deal with the difference between the velocity of the steam some 3,600 feet per second, and the desired speed of the turbine, much slower than that. Two pressure stages, each of three wheels, give a peripheral velocity of 425 feet per second in the Curtis turbine. To use steam at an equal efficiency in other turbines would require, according to the article, eighteen steps of pressure-compounded De Laval wheels, or 72 expansion stages (36 fixed and 36 movable) in a Parsons turbine. (Burleigh 1910, p. 510)

The simplicity of the Curtis units derived from several features. They mounted both prime mover and generator on a single shaft and required far fewer moving parts. Because there were none of the lateral strains and thrusts of the reciprocating engines, foundations were "a matter of less importance than with any other steam prime mover." (Burleigh 1906, p. 51) Maintenance was easier because the vertical configuration left all parts of the turbine and generator accessible and because the single turbogenerator shaft rested on a single thrust bearing that was easily replaced. (Burleigh 1906, p. 40) In May 1904, General Electric published a pamphlet including four pages of scale drawings comparing the floor space and height required by engines and Curtis turbines in 100 KW, 500 KW, 1,500 KW and 5,000 KW sizes clearly demonstrating the space savings of the turbines. (pp. 25-28) Given the pressures on central-city generating facilities, it seemed clear the vertical "compact design results in marked savings in land, buildings, foundations, and equipment." (Burleigh 1906, p. 70)

Finally, General Electric achieved significant improvement in the design of the units. As one example of the results of this effort, the four original 5,000 KW units installed in the Fisk Street Station in Chicago in 1904, were replaced by 12,000 KW units in 1909. "These occupy no greater space than the original machines and no increase in the capacity of the boilers supplying them was necessary." The report went on to claim the "kilowatt per square feet of station has been more than doubled" while also achieving a 25 percent increase in steam economy. (Parker 1910, p. 64-65) The message to those needing to expand electrical generating capacity but unable to expand existing stations was clear. By 1909, 1,200 Curtis units were installed across the United States and another 200 were on order. (Kirkland 1909, p. 101)

The vertical arrangement of the Curtis turbine was successful for the early middle-sized, slowly rotating machines. Between 1908 and 1913, however, General Electric gradually abandoned this form. Customers demanded larger machines, which meant more stages and a longer shaft; this was more easily accomodated in a horizontal configuration. New materials made possible faster speeds, up to 3,600 rpm, which required a stiffer structure than could be provided to a vertical machine. (A.S.M.E. 1975, p. 6) These new materials also proved the demise of the Curtis velocity-compounded multiple-row wheels. An engineer, reviewing the history of the Curtis turbine, wrote:

> . . . the reasons why the multi-row Curtis wheel was so successful are not . . . self-evident.
>
> The facts of the case seem to be that the time was not yet ripe for an expensive multi-stage single-row construction such as characterizes a modern high-efficiency machine. The Curtis multi-row wheels proved far mor efficient than the single-stage De Laval machine and far cheaper, more compact, and rugged than the many-stage reaction Parsons machines of that day. The De Laval machine was decidedly limited in capacity. With only low-grade materials available, the Curtis arrangement was ideally adapted to effect the required energy conversion with a minimum of wheel speed; whereas, neither a single-wheel design nor a reaction design could do this. Some such considerations surely explain the general preference for the Curtis turbine at the time and its great success. (Robinson 1937, p. 242)

For this brief period, 1903-1913 (the Georgetown units were installed in 1906 and 1907), the vertical steam turbine generator units manufactured by General Electric swept the market. General Electric established its significance as a manufacturer of steam turbines, and in fact, rapidly developed the technology they pioneered with the Curtis machine. Requiring one-tenth the space of a corresponding engine-generator unit and one-third to one-half the steam, the General Electric units made possible the large central-station generating plants that characterized urban electrification for at least a quarter of a century. Yet the success of these units was short-lived: General Electric itself saw the limits on the vertical configuration and began as early as 1908 to move toward a horizontal Curtis unit for units of the largest size (20,000 KW was apparently the upper range for the vertical units). The tremendous expansion in demand for electricity forced the rapid replacement of smaller and less efficient units leaving only two solitary surviving examples of what was once a development of overwhelming significance. Even at Georgetown, a third horizontal unit, installed in a small addition to the original plant in 1919, is remarkably smaller than either of the first two vertical units and yet produces power roughly equal the two older units combined, thus repeating the very process that once established the hegemony of the

General Electricity/Curtis vertical steam turbine generator over the engine/generator units in use in 1900.

II. Stone and Webster, Seattle Electric and the Georgetown Steamplant: Structure and Equipment

The early lead of Seattle in electric streetlighting and electric railways, as well as its large number of small, often under-financed, generating companies proved an excellent expansion area for the Boston-based firm of Stone and Webster. In 1899, Stone and Webster purchased the Union Electric Company, created their own Seattle Electric Company as a Stone and Webster subsidiary, and within one year acquired an additional sixteen local steam generating companies. (Phelps and Blanchard, p. 151; Dick, p. 3) Seattle Electric petitioned the city for exclusive operation of the street railway system and received the franchise amidst much public debate over the Stone and Webster "syndicate." (Dick, pp. 47-50) The company proceeded to improve, unify, and extend the system, creating the Puget Sound Power Company to construct a major hydroelectric facility at Electron on the Puyallup River in 1904. (The Argus, 17 Dec. 1904, p. 32) Between 1905 and 1910, the Seattle Electric Company's load increased from 10,000 KW to 30,000 KW largely in response to the growing railway system and increased domestic and industrial use.

Electricity was fast becoming a way of life. Customers were less willing to accept power failures -- peak load capacity became crucial. Because the Seattle Electric Company faced the competition of both the municipal utility and the Seattle-Tacoma (Snoqualmie Falls) Power Company, additional back-up or peaking power appeared essential. The Georgetown Plant, Seattle Electric Company's second major new steamplant after construction of the Post Street plant in 1902, gave the company an additional edge on competition and further bolstered the system's stability. (Dick 1965, pp. 52-82)

The Board of Directors of the Seattle Electric Company voted to approve the construction of a steamplant in Georgetown at their August 26, 1906, meeting. No records of the site selection process have been uncovered, but there were a number of reasons why the Georgetown site was clearly a wise choice. Land in Georgetown on the Duwamish River was readily available at a good price. The site was situated on the route of the transmission line from Stone and Webster's hydroelectric facility at Electron. The company's own electric car barns and maintenance shops were already located in Georgetown, the interurban line ran in close proximity, and the area was ripe for industrial development.

Building the Georgetown Steamplant

The decision to build the plant was apparently made before the meeting; the earliest blueprints for the plant date from May, 1906, and the Stone and Webster Unit Cost Record gives a start date of 1 April 1906. The Stone and Webster Construction Company, a branch of the Stone and Webster Company which managed the Seattle Electric Company, was to design and build the Georgetown plant for cost plus a fixed fee of $30,000. The contract included the provision that Frank B. Gilbreth, a contracting engineer and specialist in the construction of reinforced concrete power plants, be hired to design and erect the building for cost plus a fixed fee of $20,000. (Puget Sound Power and Light, Box 116)

Frank B. Gilbreth (1868-1924) was a self-taught mechanical engineer and a major contributor to the field of scientific managment. From his first apprenticeship in bricklaying at the age of 17, Gilbreth rose quickly to become head of one of the largest contracting and building firms in the nation. His invention of a portable gravity concrete mixer, patented in 1899, was an overwhelming financial success that allowed him to expand his Boston-based construction business at a rapid rate. A strong believer in the value of advertising, his promotional materials emphasized his expertise in the new field of concrete construction. By his mid-thirties, Gilbreth's contracts spanned the continent from Boston to Seattle. By staying abreast of technological advances in reinforced concrete construction, and by remaining ever interested in the value of speed and efficiency in any job, Gilbreth established a solid national reputation as a top expert in the construction of power stations, dams, and other types of industrial structures. His work in this area culminated in his book <u>Concrete Construction</u> published in 1906. (Yost, Chapter I-VIII)

Gilbreth's theories on the value and efficiency of reinforced concrete and efficient construction techniques were put into full effect at the Georgetown Steamplant. Gilbreth himself wrote about the project in an article published in a California technical journal in 1908. Noting "the structure is a unit which it is intended to duplicate from time to time as necessity demands." (Gilbreth 1908, p. 23) Gilbreth explained the original plans for the plant had called for a steel frame with brick curtain walls. The waiting time for structural steel was some five months and the scarcity and high wages of mechanics to construct such a structure in Seattle were prohibitive. Reinforced concrete, which first came into wide use in the early years of the twentieth century, was selected instead. Power plants like Georgetown especially benefited from the special characteristics of reinforced concrete: it is fireproof, stands up well under vibration, and requires little maintenance. (Gilbreth, pp. 23-25)

With characteristic assertiveness, Gilbreth wrote: "Like most of the work undertaken by Frank B. Gilbreth, speed was of utmost importance, and it was desirable to begin driving piles directly after the contract was signed." (Gilbreth, p. 24) Just before pile driving was completed, working drawings for the foundation were completed. While the foundation was in progress, working drawings for the superstructure were finalized. For cost effectiveness, washed gravel instead of broken stone was used in most places. Reinforcing rods, generally round rods, were cut to schedule and shipped by rail from Pittsburgh directly to Seattle. Gilbreth even hired a man to oversee loading of these rods and to travel with them to insure timely delivery. While the final working drawings were being completed and the rods on their way from Pittsburgh, workers erected scaffolding to the full intended height of the entire structure just outside the outer walls. From this staging, all forms could be constructed, concrete poured, forms removed and the completed building washed down. (Gilbreth, pp. 24-25)

Construction planning apparently started as early as April 1906, but actual work on the building began after August 1906. (Stone and Webster, Unit Cost Record, Sheet 1) By December, The Argus reported: "Undoubtedly one of the most important of the improvements now being made by the Seattle Electric Company is the new power generating plant and machine shops located at Georgetown. The building . . . is of reinforced concrete, built in the most approved style and on a solid foundation made of piles and masonry which will last for ages. (Dec. 15, 1906, pp. 63-64) Materials used in construction included 1,712 piles in the foundation, 3,480 cubic yards of concrete in the superstructure and another 2,700 in the machinery foundations. A Weber concrete chimney 268 feet high and seventeen feet in diameter served the boilers. (Gilbreth, p. 24; Stone and Webster, Unit Cost Record, Sheet 1 and 2) In March 1907, before the plant was complete, Seattle Electric voted to order and install a second turbogenerator. The building was designed for such expansion, so space was available for the new unit, its boilers and auxiliary equipment. This second unit of 8,000 KW more than doubled the generating capacity of the plant and extended the completion date to January 1908. (Puget Sound Power and Light, Box 116, 14) Total cost for the complete generating plant: 921,031 dollars. (Stone and Webster, Unit Cost Record, Sheet 5)

The Georgetown Steamplant was a state-of-the-art example of reinforced concrete powerplant construction. The Engineering Record of June 1908 (pp. 721-724) included a standard technical report on the new facility.

> The station building is a reinforced-concrete structure, 80 x 218 feet in plan, and with a height of 68.25 feet from the ground line to the top of the roof. The reinforced-concrete frame, and the side and end walls of the building, stand on spread footings of concrete carried by piles driven to refusal. 1,800 piles being

used to secure and stable foundation for the building and equipment. The side walls of the building are 10 inch reinforced-concrete slabs carried by columns spaced 16 feet apart on centers; the end walls are 6 inches thick and are carried by columns spaced 15 feet 1 inch apart on centers. The roof consists of 5 inch reinforced-concrete slabs carried by beams and girders resting on the wall columns and on rows of columns in the interior of the building.

The building is divided by a transverse 6 inch reinforced-concrete wall into a boiler room and a generator room, the former being 153 feet 10 inches long, and the latter occupying the remainder of the building. A basement, with its floor at the ground level, extends under the entire boiler room. The boilers are on a reinforced-concrete floor over this basement, which floor is carried by reinforced-concrete columns on spread footings on piles.

. . . The floor of the generator room is carried by 65 foot span reinforced-concrete girders, exiting from the transverse partition wall to the end wall of the building, so this room is entirely free of columns. The switchboard, wiring connections, switches, transformers and electric auxiliaries are at the opposite side of the generator room from the boilers, in a reinforced-concrete gallery having four floors above the generator room floor.

Gilbreth discussed other features in his 1908 article including calculations of the economy and safety of reinforced concrete beams and the very long beams transversing the engine room. These sixty-five foot long girders were to his knowledge "The longest span of any ever constructed whose section, at the point where maximum bending moment occurs, is rectangular." (Gilbreth, p. 26) Permanent in character, free from vibration, and fireproof, the Georgetown Steamplant building stood ready to receive its complex assortment of electrical generating equipment.

The Machinery and Operation of the Georgetown Steamplant

The basic concept behind a steam turbine electrical generating plant is straightforward. A source of heat, in this case coal or oil, is used to turn water to steam. The steam, under pressure, is directed against the blades of a turbine, causing it to turn. A generator is turned by the turbine, producing electricity. The actual operation, of course, is not nearly as simple as this much abbreviated description. Every step in the process is made as efficient as possible. Though in some ways primitive compared to modern plants, the Georgetown Steamplant was the product of an advanced science and engineering.

What follows is a description of the machinery at the Georgetown plant and its mode of operation when it was new, in 1907; changes will be mentioned later.

The Boilers

The Georgetown plant was built to burn both coal and oil. Complete facilities to handle either fuel were designed into the plant. In its early days and in recent years the plant has been powered by bunker oil which was stored in a 150,000 gallon steel tank near the plant, pumped into the plant, heated and delivered to the boilers. Oil was transferred to the front of the boilers by 2-1/2 inch pipes. At the burner, the oil was steam-atomized in special nozzles to ignite more easily. (In startup, when there is no steam, the oil was atomized with compressed air.) The atomized oil enters from the burners in the front of the boilers into the combustion chamber.

Though not used at first, a complete coal delivery system was also built into the plant. Coal arrived over the Seattle Electric Company's street railways. At the rear of the plant (the southeast side) a conveyor belt lifted the coal to the top floor Another conveyor near the ceiling of the boiler room carried the coal to eight funnel-shaped bunkers from which coal dropped to the boiler room and moved into the burners by mechanical chain-grate stokers built by the Green Engineering Company. After burning, the ashes could be dumped from the bottom of the boiler into an ash car which ran on rails in the basement beneath the boilers.

The six boilers producing steam for the 3,000 KW turbogenerator were served in turn by a 125-foot steel stack eleven feet in diameter. The row of boilers on the other side of the room connected to a 268-foot high, 17-foot in diameter reinforced concrete stack 55 feet from the building. This stack had the capacity to serve a planned expansion of ten additional boilers.

Feed water for the Georgetown boilers came from the Duwamish River, on which the plant was located. A 10-inch pipe ran underground in a concrete-lined 6 x 10 foot-trench. Two Blake steam-driven reciprocating pumps brought water to a 13,280-gallon steel tank. This large overhead tank furnished water to six boilers serving the 3,000 KW turbogenerator as well as the six serving the larger turbogenerator. This water supply or "feed water" had to be heated, a step accomplished by using the exhaust steam of the turbogenerator's auxiliary equipment.

There were originally fourteen water tube boilers at the Georgetown plant. Six on the southwest side of the boiler room provided steam for the 3,000 KW unit; the eight on the northeast side of the room serviced the 8,000 KW unit. The boilers, built by the Stirling Consolidated Boiler Company, were rated at 466 H.P. each. Seven of the fourteen boilers at Georgetown -- every other one -- provided superheated steam, raising steam temperature from about 390 to 520 degrees. There are several advantages to superheated steam. The boiler is made more efficient because the added energy in the steam is in part gained from heat which would otherwise be wasted. Superheated steam has a lower thermal conductivity than saturated steam and therefore loses less heat to the pipes. Most important, however, are the advantages of superheated steam in the turbines. Superheated steam is used more efficienty by the turbines than is saturated steam. The Georgetown plant probably gained an increase in efficiency of between 10 and 15 percent through the use of superheated steam. The boilers and their fuel delivery system take up the large wing of the Georgetown Steamplant. They deliver steam to the smaller wing where the turbines, their auxiliary equipment, and the electrical equipment is located.

Turbines

There are two vertical Curtis steam turbogenerators at the Georgetown Steamplant, apparently the last of their type still in operating condition. Turbogenerator Number 1, the smaller unit -- the turbine produced 4,000 H.P., the generator 3,000 KW -- is a four-stage machine, each stage having two movable and one stationary wheel. Turbogenerator Number 2, a 10,700 H.P., 8,000 KW machine, has five stages and is larger, but otherwise similar to Number 1. Both were "run condensing," that is, they were operated so that spent steam discharged into a condenser held at a vacuum.

The turbines were fed with superheated steam from the boilers. It entered the turbine through two sets of nozzles located 180 degrees apart. (One of these was for regular use and admitted steam to the first stage; the other, opened when the turbogenerator was running on overload, above its rated capacity, admitted steam to the second stage.) The nozzles were regulated by a governor which opened or closed one or several of the first or second stage nozzles. The governor kept the turbine at a constant speed of 720 revolutions per minute; more nozzles were opened when a heavier load was placed on the generator. When all of the first stage nozzles were opened, the band of steam covered about one-sixth the circumference of that stage; at the last stage the steam covered the complete circumference of the machine. A nozzle was either completely open or completely closed; only the amount of steam, and not its velocity, was regulated.

The steam entered the turbine at a pressure of about 175 pounds per square inch. It hit the first, movable, row of blades, pushed it and was deflected to the fixed row and then to the second movable row, through that row and then to the nozzles of the second stage. The steam passed through each of the stages in a similar fashion, each at a lower pressure. In the 3,000 KW turbogenerator for example, the pressure is reduced from 175 psi at the first stage to about 50 psi on entering the second stage, 5 psi on entering the third stage, to a partial vacuum on entering the fourth stage. It exited the fourth stage at the condenser vacuum of about 2.8 inches of mercury (1.4 psi absolute). The steam gave up about one quarter of its energy to each stage.

From the last stage of the turbine the steam is directed to the condenser. Both turbines at the Georgetown plant make use of Weiss counter-current barometric condensers, tall metal towers behind each of the machines. The condenser for Turbogenerator Number 2 rises to 54-1/2 feet above the floor; its shell is 9 feet in diameter. Some 130,000 pounds of steam per hour was delivered to it by a pipe 78 inches in diameter, entering the condenser 41 feet above the floor. Water entered near the top, was forced up the tube a small way, and then plummeted down the tube past a cone which broke it into a fine spray. Steam entered below the water, and was combined with the water and cooled by it as it plummeted down the tube. It was discharged into a "hot well" measuring 14 x 14 x 7 feet at the bottom of the main barometric tube. Inside the tube a column of water was held at a height of about 30 feet by the vacuum generated by the horizontal tandem Weiss crank and fly-wheel air pump located next to each turbine.

Water for the condensers was drawn from the Duwamish River, pulled through a 16 inch pipe by a centrifugal pump direct-connected to a 10 x 12 inch high-speed Porter-Allen engine (for the 3,000 KW unit) and an 18 inch horizontal centrifugal pump driven by an 11 x 14 inch high-speed Porter-Allen engine (for the 8,000 KW unit). This latter pump provided 7,500 gallons of cooling water per minute, and the smaller pump proportionately less After passing through the condenser, the water, heated to about 115 degrees, was discharged back into the river via a tunnel 8 x 12-1/2 feet in cross section. This concrete-lined tunnel was 300 feet long, extending some 200 feet downstream of the intake pipes.

Electrical Equipment

The generators at the Georgetown Steamplant are mounted on the same shaft as the turbines which turn them. Both units are 3-phase, 60-cycle, 10-pole separately excited revolving field generators designed to deliver current at 13,800 volts, and to operate at a speed of 720 revolutions per minute. Unit Number 1 produced 3,000 kilowatts, Unit Number 2, 8,000 kilowatts.

The auxiliary electrical equipment at the Georgetown Steamplant is located in the galleries on the far wall of the engine room from the boilers. Three exciters on the first floor powered the magnetic field of the large generators. The 3,000 KW generator had two exciters, a 40 KW electric motor driven, direct current generator and a 75 KW steam driven, direct current generator. The 8,000 KW generator had a single 120 KW motor driven exciter. The steam exciter was powered by a 130 H.P. Porter-Allen engine.

The Georgetown Steamplant was used as a substation as well as a generating station. In the first floor gallery are the transformers and motor-generators which converted some of the high voltage alternating current produced by the large generators and by other plants in the system to lower voltage current for specific uses. Two 500 KW motor generators provided 600 volt direct current to the Seattle Elecric Company's street car system and to the Seattle-Tacoma interurban railroad.

All of the electrical equipment in the station is controlled from the third floor gallery. The reporter for the Engineering Record described it in some detail:

> The main units are arranged for remote control from panels in the third gallery floor. A cable from each phase of both main generators is carried from the latter in brass pipes leading to conduits under the floor of the generator room. These conduits extend to the end wall of the building at the rear of the galleries, and the cables are carried up a 12 inch space between this wall and the gallery floors to motor-operated oil switches on the fourth floor of the gallery. On the third floor of the galleries are also located panels controlling the railway motor generator and the railway feeder circuits; also panels for local light and power service. All panels of this switchboard are of blue Vermont marble mounted with standard General Electric switches and recording and measuring apparatus. The gallery floors are entirely of reinforced-concrete and are reached by stairways of concrete, so the gallery structure is fully fireproof. (June 1908, p. 724)

The fourth floor contains the motor-operated oil switches used on the high-tension lines leading from the plant. The connections to the outside are made on the fifth floor of the gallery, which also contains lightning arresters and static dischargers.

Changes in the Georgetown Steamplant

The machinery in the Georgetown plant has been altered only slightly over the years of its operation. The plant remains close to its original condition, but a succession of minor alterations and a few major additions reflect the plant's changing use as well as the changes in the technology of steam generating plants.

A few days after it was put into operation on August 3, 1907, the 3,000 KW turbogenerator burned out. It was repaired but continued to cause problems, burning out three more times in the next three months. The second turbogenerator was put into service December 17, 1907, but burned out on January 7, 1908 and was not operational again until March. The troubles with the new steamplant were topped off by the explosion of a steam pipe in May, 1908, which killed G.W. Tucker, the chief engineer. Problems continued and in October F.N. Bushell was sent to Georgetown from Stone and Webster's head office to "look into the steam turbine question." His specific recommendations are unknown, but the measures taken were apparently successful.[5] In 1911, the smaller generator was rewound from 3,000 KW to 5,000 KW. (Puget Sound Power and Light, Box 119) This was a common procedure; as generator technology changed, more electric power could be produced with the same amount of mechanical energy.

In the first years after the Georgetown Steamplant was built, the Seattle Electric Company was distributing about ten million kilowatt-hours per month. (The total rose from six million KWH in 1907 to eleven and one-half million KWH in 1910.) Most of this power was bought from other companies. Puget Sound Power Company's Electron plant produced about 70 percent of this power, Seattle Tacoma Power Company's Snoqualmie Falls plant about 15 percent, and the Tacoma Company about 10 percent. The rest was provided by the Seattle Electric Company's steamplants, mostly the Post Street Steamplant, which operated continuously to provide steam for heating. The Georgetown plant, used as a peaking facility, operated mostly between six o'clock and ten o'clock in the morning and three o'clock and eight o'clock in the evening, when demand was heaviest. Most of the Seattle Electric Company's power, up to 90 percent of it at peak times, was used to operate its street cars. The Georgetown plant was run more in the fall and the winter, when water for the hydroelectric plants was low, and also more toward the end of the first five years, reflecting increased demand. (Puget Sound Power and Light, Box 119)

In 1912, the Massachusetts-incorporated firm of Puget Sound Traction, Power and Light purchased and consolidated the Seattle Electric Company along with the Seattle-Tacoma Power Company (Snoqualmie Falls), the Pacific Coast Power Company, the Puget Sound Power Company, and the Whatcom County Railroad and Light Company. The new corporation was another Stone and Webster enterprise. The merger combined four major hydroelectric plants as well as four steamplants in Seattle and Tacoma, and it established electrical service on a regional basis for the first time in western Washington. The effect of the consolidation was increased dependability of the system and reduced rates.

This 1912 consolidation of all major electric companies made the Georgetown Steamplant a part of a larger network. Cheaper power from hydroelectric plants, including the new 14,000 KW White River facility, supplied the bulk of the demand. For a short time, the Georgetown plant was used only to supply steam heat to the company's nearby car barns. A company brochure of 1912 mentions the Georgetown plant as being "used only in cases of emergency." (Electric Journal 1912, pp. 50-51) A 1915 history of Seattle notes that "not one percent of the current for the city is generated by steamplants," but adds that they are kept ready for emergencies. (Bagley 1915, p. 442)

The American entry into World War I spurred the growing demand for electrical power in the Puget Sound region. Puget Sound Traction, Power and Light did not have the capital to build an additional hydroelectric plant to meet the new demand, but instead expanded its White River hydroelectric plant and its steamplant at Georgetown, adding to the latter, a 10,000 KW horizontal Curtis steam turbogenerator. (Lubar, pp. 24-25) The new equipment was installed and ready for use on May 18, 1919. (Puget Sound Power and Light 1921, p. 7) The new unit required an addition to the building, a small structure added to the north corner of the building. Two new boilers and alterations to increase the power of seven of the old boilers from 460 to 552 H.P. were added to provide power to drive the new turbine. These were serviced by a new smokestack. Several new transformers were added to deal with the additional power. Cooling water for the horizontal turbine was held in a concrete overflow tank on the southwest side of the plant. Water was piped to this tank and then to the condenser. At the same time the new turbogenerator was added, ducts were installed to supply cooling air to the old turbogenerators in order to increase their overload capacity.

Two other major changes to the Georgetown plant were made in the 1917 to 1919 period. In 1917, the course of the Duwamish River was changed and the Duwamish Waterway created by the Army Corps of Engineers necessitated a number of alterations in the means by which the plant drew its boiler and condenser water. A new pump house was built on the bank of the waterway, and the old connections replaced with a wood-stave pipe for intake condenser water and an open wood-lined trench for its exhaust.

As early as 1909, the Seattle Electric Company had had trouble getting enough oil for its plants, and in 1917, the fuel used by the boilers at

Georgetown was changed from oil to coal. This switch had been foreseen, and the plans for the plant had provided for most of the coal handling equipment already. All that was needed were a system of conveyors, a coal pile outside the plant, and ash removal facilities.

In the 1920s, demand for power increased greatly. Puget Sound Power and Light (they dropped their traction service in 1919) increased the size of several of their hydroelectric plants to meet the need. There was still need for a steam peaking facility, but by the end of the 1920s, the Georgetown plant was outdated and too small to be of much use. In 1930, Puget Sound Power and Light built a new steamplant, the Shuffleton plant at Renton, Washington. This facility with a capacity of 113,000 H.P., largely took over the Georgetown plant's role of standby steamplant. The 1930s and 1940s were times of increased interconnection among power companies, and also of the great federal hydroelectric projects in the Pacific Northwest. More power was available, and the need for the Georgetown plant decreased. A 1948 Puget Sound Power and Light Company Report mentions that in years of average stream flow the plant was used only one hundred hours per year, but that about every four years, because of reduced water flow, the plant saw more use. (Ford, p. 28) In the late 1940s and early 1950s, the plant was occasionally operated in the winter, when there was not enough water to allow the hydroelectric plants to supply peak demand.

Another major change came to the plant in 1937 with the construction of Boeing Field just south of the steamplant. Both stacks were razed to clear the ends of the runway, and a new induced-draft ventilation system installed in their stead. The openings where the ducts to the stacks exited the plant are still visible, bricked over, on the southeast side of the building.

The last major change in the building was made in the late 1940s, when the plant switched from coal back to oil. For a while, the plant was set up to burn either fuel, but when the price of oil fell after World War Two, the facilities for coal handling were removed and the plant switched permanently to oil.

In 1951, the Georgetown Steamplant was purchased by the City of Seattle Department of Lighting, now Seattle City Light. Very little changed. Most of the employees at the Georgetown plant were simply transferred from the old company to the new, and the machinery kept in its former condition. Seattle City Light already had a steamplant, the Lake Union facility, which meant that the need for power from the Georgetown facility was further reduced. The Georgetown Steamplant's last production run was from November, 1952, to January, 1953, during a major water shortage.

In recent years the place has been run only for tests. The Bonneville Power Authority gave credit to Seattle City Light for having the plant as a standby facility. In order to receive this credit it was necessary for City Light to operate the plant occasionally. Turbine Number 1 was last run on November 28, 1972. Turbine Numbers 2 and 3 on November 14, 1974. On June 20, 1977, the plant was taken off the Bonneville rolls. It could not meet environmental standards, and was thought to be unreliable. It has not operated since.

III. Urban Electric Power Development and Use in Seattle

The Georgetown Steamplant played neither a dominant nor crucial role in the electrical history of Seattle. It was, instead, a part of a growing complexity of electrical power generation facilities designed to supply consumers with ever-increasing quantities of power. In streetlighting, transportation, and in industrial and domestic use, the ability to provide increasing quantities and stable supplies of electricity proved crucial to corporate success. Seattle, Stone and Webster, and Georgetown all reflect this national trend toward corporate consolidation, technological improvement, and ever-increasing consumption.

Electricity in Seattle: 1886-1928

In the mid 1880s, Seattle was a city of horse-drawn trolleys and gas lighting. By the close of that decade, the city had moved to the forefront of communities across the nation in the manufacture and application of electrical power. A Seattle company established the first Edison incandescent central station lighting plant west of the Rocky Mountains in 1886. (Dick 1965, pp. 1-2; Hanford 1924, p. 265; Beaton 1914, pp. 105, 120-121) The Seattle Electric Light Company obtained a contract for streetlighting in the same year. Shortly thereafter in 1889, Seattle electrified its horse-drawn trolleys and became the fourth city in the world to establish an electrical railway system. (Bagley, pp. 429-438)

At first Seattle reacted skeptically to the new power source. One observer of the electric railway construction warned the president of the company, "Don't you see that you can never operate in winter? The rains will wash the current off the wires and you will not be able to turn a wheel." (Beaton, p. 107) One pillar of the community remarked in reference to the streetlighting company's steamplant "How foolish of these young men to build the generating station on the waterfront. If they had put it at the top of the hill the electricity would run down the wires by gravity. Now they'll have to pump it." (Dick, p. 2)

Since its beginning in 1873, the Seattle Gas Company held a monopoly on the streetlighting of Seattle. Alarmed by the upstart electrical industry, the company changed its name to Seattle Gas and Electric in 1886, determined to survive the competition. They built a steamplant at Fourth and Main and provided the city's first carbon arc lighting, a far more efficient method of illuminating large open spaces. (Phelps and Blanchard 1978, pp. 49-50)

The next company formed in response to the growing demand for electricity was Dr. E.C. Kilbourne's Pacific Electric Company. Kilbourne's experience came from his early involvement in the electric railway system of the previous few years. Pacific Electric leased the old powerhouse and equipment from the railway company and hired Baker and Balch, Seattle's first electrical engineering contractors, to put up the pole line. (Beaton 1914, pp. 122-123)

Both of these early firms were reorganized under new names, and by 1892 had merged to become the Union Electric Company -- this became the major (but by no means the only) generating and distributing firm serving Seattle in the next decade. A multitude of small companies with steamplants in the basements of downtown buildings sprang up, and there were many mergers and reorganizations. Competition was fierce and rates remained uniformly high. (Beaton, pp. 124-125)

In 1899, the Boston-based engineering firm of Stone and Webster took over Union Electric. By 1900, a total of some seventeen small locally-based utility companies had been absorbed by Stone and Webster's Seattle Electric Company. (Beaton, p. 112a) When the near-monopoly petitioned the city for a consolidation franchise for exclusive operation of the local street railway system, much public debate arose. Anti-corporation, pro-municipal ownership coalitions formed the basis of the opposition. The Stone and Webster "syndicate" was viewed by many as a foreign monopoly, an "octopus" out to sap and plunder the resources of the burgeoning city. Nevertheless, the street-railway franchise was granted, and the Seattle Electric Company proceeded to greatly improve, unify, and extend the system throughout the city for the next decade. (Dick, pp. 47-50)

In December of 1906, The Argus reported a projected expenditure of $1,800,000 for 1907 for "improvements, betterments, and new equipment" in Seattle. Population growth and increased demand for system extension were cited as reasons for the largest annual appropriation ever made by Stone and Webster to its Seattle holdings. This same article goes on to tout the construction of a new steamplant to augment its existing power generation facilities:

> Undoubtedly one of the most important of the improvements now being made by the Seattle Electric Company is the new power generating plant and machine shops located at Georgetown. The

> building . . . is of reinforced concrete, built in the most approved style and on a solid foundation made of piles and masonry, which will last for ages. (The Argus, Dec. 15, 1906, pp. 63-64)

The year 1912 signaled the end of the era of local power supply. Stone and Webster purchased and consolidated utility holdings in Bellingham, Everett, Seattle, and Tacoma including four major power companies and three major hydroelectric plants, under the umbrella of the Puget Sound Traction, Power and Light Company. Territorial power supply in Pacific Northwest had begun. (Chronological History, pp. 6-7)

Competition

During the heyday of Stone and Webster, the Snoqualmie Falls Power Company provided a measure of competition for the Seattle Electric Company. The Snoqualmie Falls project was Washington's first major hydroelectric project, and was built and operated by Charles Baker in 1898. By mid 1899, Snoqualmie Falls supplied power to portions of Seattle's street railway system and to various stationary motors and flour mill operations around the city. But by arrangement with Stone and Webster, the Snoqualmie Falls Power Company only sold power wholesale to Seattle Electric, and the latter handled all retail distribution within the city. (Dick, pp. 51, 83-84)

The turn-of-the-century movement toward a municipal utility system produced serious competition for the Seattle Electric Company by 1905. The momentum began with a public vote in 1896 to consider the Cedar River as a power source after the completion of the city water works there. This populist sentiment grew in strength until the election of 1902 which authorized construction of a hydroelectric project on the Cedar. City Engineer R.H. Thompson hired J.D. Ross as electrical engineer on the project The Cedar River plant first supplied current to the city in January of 1905. Its distribution station was built on Yesler Way at Seventh Avenue The city's top priority was to service its eleven street lighting circuits, and was soon competing with the Seattle Electric Company in private domestic lighting. At the end of the first year of operation The Argus wrote:

> The municipal electric lighting and power plant is now in successful operation, and is supplying the city with four hundred and fifty arc lamps, an increase of two hundred and fifty, and nineteen hundred incandescent lights . . . It is also supplying power for manufacturing purposes, and has installed lights in a considerable number of private homes. (The Argus, Dec. 23, 1905, p. 21)

The absolute superiority of hydro-generated electricity was realized in the first decade of the new century. Hydroelectricity meant more current for less work with a resulting radical decrease in consumer rates. The Seattle Electric Company originally relied on small steam-generating plants, as had its predecessor companies. But in 1904, Stone and Webster, under the name of the Puget Sound Power Company followed the lead of Charles Baker's Snoqualmie Falls project and constructed a major hydroelectric plant at Electron on the Puyallup River. Electron meant substantial rate reductions for the people of Seattle. (The Argus, Dec. 17, 1904, p. 32)

By 1905, the Snoqualmie Falls, Electron, and Cedar River municipal plant supplied Seattle with the bulk of the electrical power needed to meet its transportation, street lighting, private domestic, and industrial needs. These major sources were amplified in 1912 by the Puget Sound Traction Power and Light Company's White River hydroelectric project. Through the first decade of the century, steamplants continued to be built as auxiliary power sources. Steamplants such as the Seattle Electric Company's Georgetown plant, provided power companies with back-up and peak load capability. They meant stability and the guarantee of uninterrupted service. This peak hour capability was what small utility companies lacked and was the ultimate reason for their failure.

In 1912, Puget Sound Traction, Power and Light purchased and consolidated the Seattle Electric Company along with the Seattle-Tacoma Power Company (Snoqualmie Falls), the Pacific Coast Power Company, the Puget Sound Power Company, and the Whatcom County Railway and Light Company. The new corporation was another Stone and Webster enterprise. The merger combined four major hydroelectric plants as well as four steamplants in Seattle and Tacoma, and it established electrical service on a regional basis for the first time in western Washington. The effect of the consolidation was the increased dependability of the system and reduced rates. Gradually, the corporation bought up small utilities in outlying towns where peak demands were too difficult to meet without a steam power backup system. (The Argus, "Preparedness for Industrial Development," p. 61)

From 1910 through 1920, the demand for electric transportation in Seattle decreased. The electric streetcar system was sold to the city in 1919, and Puget Sound Traction Power and Light dropped the "Traction" from its name. By 1924, the company provided service from "tide water on the west to the Columbia River on the east and from the international border on the north to points in Oregon on south." (Hawford, p. 267) In 1928, Stone and Webster sold out of the company. Puget Sound Power and Light remains in operation today, still the predominant private regional power supplier in the Puget Sound country.

IV. Urban Electricity from Luxury to Necessity

The early twentieth century, the time when the Georgetown Steamplant saw its most intensive use, was one that transformed electricity from a novelty to a necessity. In streetlighting, transportation, and in domestic and industrial use, electricty became a necessity, a power source that had to be supplied in ever-increasing yet dependable quantities every day. As a rare surviving "peaking" facility, the Georgetown plant supplied back-up power for all these uses. It was an era initiated by small urban steamplants, later dominated by more remote hydro-electric facilities and their standby peaking facilities, and eventually replaced by even larger hydroplants and a new generation of massive steamplants.

The yellow glow of gas lamps first illuminated the streets of Seattle on New Year's Eve in 1873. During the 1880s the coal gas plant and the service it provided were considerably expanded, and by the end of the decade gas lighting in the home was a clear symbol of status. (Phelps and Blanchard, p. 148)

With the availability of electricity, street gas luminaires began to be gradually replaced, first with incandescent (carbon filament) and soon afterward with carbon arc lights. The latter were suspended on cables over intersections or from outriggers on utility poles. Arc lighting was the most effective means of illuminating large open spaces, although incandescents remained in use in suburban areas requiring less intense lighting. In 1893, the enclosed arc was introduced, and eliminated the need for the daily replacement of carbons. (Phelps and Blanchard, pp. 149-152) Until 1909-1910, Seattle's streetlighting system as a whole was haphazard and non-uniform in design. The City Engineer's Annual Report of 1891 noted that the city was using a total of 89 arc lights, 282 30 c.p. incandescent lights, and 303 15 c.p. incandescents to light its streets. (Phelps and Blanchard, pp. 151-152)

The cost of electric lighting in the home remained relatively high until the tremendous reduction in cost made possible by hydroelectric power developments. In the early 1890s, however, the flat rate cost of a single 16 c.p. lamp in the home ranged from around $1.50 to $3.00 per hour depending upon the hours of use. (Pacific Electric Company rates, Beaton, p. 123) Gas lighting continued to provide competition in home illumination into the twentieth century. (ads in <u>The Argus</u>, Dec. 1899, 1901)

The City of Seattle gained control of all streetlighting in 1905 with the opening of the Cedar River power plant. As the city assumed metropolitan proportions and character, the haphazard mixture of street lighting types and designs became more and more unacceptable. In 1909-1910, replacement of the entire system with a uniform cluster light design took place for a total cost of $51,279. The project instigated by the downtown businessmen who petitioned on the basis of a local Improvement District, and the lights themselves were designed by J.D. Ross. The new arrangement used five or three ball clusters of 80 c.p. tungsten lamps with lightly-sandblasted globes on ornamental iron poles. The system was an understandable source of city pride, as the City Lighting Department's Annual Report of 1911 indicates:

> Seattle's cluster lighting system is one of the finest in existence and is generally admired by tourists and visitors from all parts of the country . . . . This design gives a beautiful effect of festoons of decorative lights along the sidewalks, and at the same time secures a uniform illumination on all parts of the street. (Phelps and Blanchard, p. 152)

Electric lighting effects played an increasingly important role in public ornamentation in the first decade of the century. Promotional materials for the Alaska-Yukon-Pacific Exposition in 1909 extolled not only the virtues of lighting at the exposition grounds, but also on the main commercial thoroughfares of the city itself:

> By night the Exposition is a spectacle that has never been surpassed. The grounds and buildings are a blaze of light and the Cascades -- pouring down the central court -- a plunging rainbow, showing every color of the solar prism. The Geyser Basin at the foot, is a lake of liquid fire in which trout and bass sport among sunken gardens. Every building on the grounds is thrown into brilliant silhouette by incandescent lights dotting their outlines at six-inch intervals, and the Alaska Shaft, which marks the center of the Exposition grounds, is a tower of brilliancy.

And downtown:

> At night First, Second, and Third Avenues are dazzingly illuminated by eight lamp posts in every block, each post supporting a pyramid of five electric lights, and they present a scene that is not paralleled in either Chicago or New York -- despite their size and wealth. In a word, Seattle is the modern marvel of magical city possibilities. (Seattle and the Pacific Northwest . . . A-Y-P Hotel and Commercial Guide, pp. 2 and 6)

The Georgetown Steamplant, as a facility of the Seattle Electric Company and later the Puget Sound Power and Light Company, was never a direct supplier of power to the city's lighting system. By 1905, the City Lighting Department had assumed full responsibility for streetlighting in Seattle. The ornamental one-, three-, and five-globe cluster lighting system, restored today in the vicinity of Pike Place Market and Pioneer Square, was installed in 1909 and 1910. By 1925, increased automotive traffic challenged the adequacy of that system. While it was apparent that new lighting was sorely needed, controversies over design among downtown property owners prevented installation of a new system until 1929. All cluster lighting was removed in the business district and replaced by luminaires designed by Carl Gould of the architectural firm of Bebb and Gould. By the end of 1931, this system extended into the city's residential neighborhoods.

The last major replacement of the city's streetlighting system occurred in 1948-1954 in the business district and in 1964-1968 in the residential districts. Mercury vapor lamps were installed, but in many cases the ornamental iron bases designed by Carl Gould were retained. (Phelps and Blanchard, pp. 153-161)

Transportation

Young Frank Osgood from Boston came west to Seattle in 1883 with a desire to contribute to the development of the city. At the suggestion of Thomas Burke, Osgood developed a horse-drawn streetcar system along Second Avenue with branches to Lake Union and to Belltown. Osgood's system, begun in the Fall of 1884, was the first in Washington Territory and was a feather in Seattle's cap in the bitter rivalry with Tacoma. Osgood kept abreast of developments in electricity, and in 1888 joined forces and funds with L.H. Griffith, Morgan Carkeek, Dr. E.C. Kilbourne, Judge Thomas Burke and others to form the Seattle Electric Railway and Power Company. The purpose of the company was to electrify the existing trolley line, open new territory for development, and beat the competition of the cable-car company. (Beaton, pp. 100-105)

Osgood and Kilbourne contracted with the Thomson-Houston Electric Company for equipment. A plant was built at the foot of Pike Street with an 80-h.p. generator and a 100-h.p. engine. The rolling stock included five double-reduction Thomson-Houston 15-h.p. motor equipments, four Jones car bodies with Brill trucks. Electric trolley service began at midnight on March 30, 1889, and the horse cars were retired to car barns never to run again on Seattle streets. Citizens turned out in droves along Second Avenue the following day. When the trolleys made the grade, Seattlelites cheered and the cable car company began to worry. (Beaton, p. 106)

Seattle's electric streetcar system was a tremendous success as an advertisment for the city, as a money-making venture, and as a stimulus to real-estate development. New "streetcar" suburbs were opened up for subdivision, and thus electricity became a prime factor in the rapid growth of the city. By 1891, there were 13 separate cable and electric railway companies and 48 miles of electric trackage. (The Argus, Dec.

11, 1911) Among others, the Grant Street Electric Railway built tracks on piles around the tideflats to Georgetown in 1893. A brick powerhouse with three generators supplied power for the car system with enough left over to provide electric lighting to several establishments in Georgetown. (Blanchard, pp. 37-38)

The Panic of 1893 had a disasterous impact on Seattle's electric trolley companies. All but the Madison Street Cable Company and the Seattle Traction Company went into receivership. Many trolley enterprises revived with the business recovery brought on by the Alaska gold discoveries, but the tracks and rolling stock had begun to deteriorate. Talk of consolidation of the myriad systems became a reality when the giant eastern firm of Stone and Webster entered the field. (Phelps and Blanchard, pp. 164-165)

Stone and Webster's consolidation of Seattle's myriad streetcar lines led to immediate improvements in the system. In December of 1900, G.W. Dickinson, manager of the Seattle Electric Company, reported on these improvements in The Argus, and asked the citizen's indulgence for the torn-up condition of the streets. Dickinson also noted that it was now possible for the working public to live on the outskirts of the city within a radius of five miles, and be within twenty minutes of Pioneer Square by street railway. The following year The Argus reported that:

> . . . during the past two years the lines have been nearly all rebuilt and equipped with latest improvements, both in rolling stock and other appliances, and when improvements under construction are completed, no city in the country will have better service. (The Argus, Dec. 21, 1901)

The improvement and extension of the street railway system had a direct effect on the expansion of the city. "Streetcar suburbs" grew up overnight, and the general prosperity of the times allowed working people to purchase their own homes on the installment plan. Seattle became a city of single-family-homes and well-defined neighborhoods because of this direct access by streetcar to and from the commercial center. (Seattle of Today, p. 39)

In 1902 an interurban electric railroad line was completed between Seattle and Tacoma. This efficient, rapid means of transportation opened up still more suburban areas to settlement, and brought into existence a number of new towns and villages along its route. A branch line to the coal-mining town of Renton was soon added to the system and by 1907 a line to Everett was under construction. With the operation of these roads, electrical transportation in Seattle reached its zenith. (The Argus, Dec. 20, 1902, and Seattle of Today, p. 39)

Tourism and recreation in and around Seattle were encouraged and enhanced by the Seattle Electric Company's transportation system. "Trolley parks" at scenic locations at the end of the streetcar lines at Leschi and Madison Park on Lake Washington, were developed by the Company into popular resort facilities. During the summer months as many as eight "Seeing Seattle" tourist cars were operated on tour routes throughout the city. These proved immensely popular during the Alaska-Yukon-Pacific Exposition of 1909. ("Trolley Trips About Seattle") The AYP itself spurred construction of several new streetcar lines and the upgrading of rolling stock and terminals. Outside of the city the interurbans were tourist attractions in themselves, with miles of scenic vistas of farmlands, forests, water, and mountains. (The Argus, Dec. 20, 1902, and Dec. 16, 1911)

By 1911, Stone and Webster's rate of investment in the Seattle street railway system had slowed to the extent that criticism was being raised by municipal ownership advocates. "A Short History of Seattle's Street Railway System," an article published by The Argus on December 16, 1911 was an obvious attempt to praise and defend the Seattle Electric Company's many accomplishments over the previous decade. Nevertheless, service continued to deteriorate, and the Seattle Municipal Railway came into existence in 1911 with the construction of a new line of its own. It was a taste of things to come in the next decade when the City would incrementally enter the public transportation field, and Stone and Webster interests would subside. (Phelps and Blanchard, pp. 165-167)

When the Georgetown Steamplant was constructed in 1906-07, the city's electric car service and the region's interurban service was at its peak. The Seattle Electric Company's streetcar system was the major consumer of the company's power, and it provided service to 246,000 people over 155 miles of track. By 1912, however, the operation of the system had become less profitable, and Stone and Webster's investment in its maintenance declined. Local sentiment toward municipal ownership of the system revived once again. The city had proved its interest and ability to operate such a system with its construction of the "Division A" line in 1911 and its take-over of the Highland Park-Lake Burien line in 1913. Tension and disputes between the city and Stone and Webster (by then consolidated as Puget Sound Power and Light) continued to mount during World War I.

In 1919, the city purchased the entire street railway system at the asking price of Stone and Webster. Under the contract, the city was also to take over the substations supplying street railway current. Municipal operation of the street railway system was plagued with problems. Ineligibility for state subsidies, rigorous payment terms, management changes, increased wartime traffic followed by a business slump, and finally depression led to bankruptcy of the system in 1938.

During the twenty-year life of the Seattle Municipal Street Railway, the city had purchased absolutely no new equipment. The entire system was eventually replaced by rubber tire gasoline engine vehicles -- the last electric car ran on April 13, 1941. (Blanchard, pp. 91-94, "Chronological History," n.p.)

Industrial and Domestic Use

From the first instance of industrial use of electricity in Seattle at the Lowman-Hanford presses in 1890, the application of the new power source to industry grew rapidly. In an advertisement in The Argus, of December 23, 1899, the Northwest Fixture Company offered electric fixtures, motors, dynamos, and electrical machinery and elevators for sale. In the same issue of that magazine, the Seattle Cataract Company offered cheap power from Snoqualmie Falls to grind flour, mine coal, or smelt ores.

Local articles published throughout the first decade of the century promoted Seattle as a good place to establish manufacturing concerns, precisely because of the abundance of cheap power made available through its hydroelectric and steam plant facilities. The local utility companies advertised extensively for industrial customers, even to the extent of gathering data for prospective manufacturers. W.E. Herring, Industrial Agent for the Puget Sound Traction Power and Light Company, published two such informative articles in The Argus, (Dec. 13, 1913 and Dec. 18, 1915), describing the natural resources of the Puget Sound Region, the untapped opportunities in manufacturing, and the availability of electrical power at low cost in both urban and rural areas.

New Domestic Uses

In the first decade of the new century, the application of electricity to domestic use revolutionized the operation of Seattle households. Wider application was made possible by the lower rates associated with hydroelectric generation, and by a growing understanding of the new technology. The Municipal Lighting Department's Annual Report of 1912 reported on city-wide experiments with electric heating systems, both radiant and hot water. Cooking with electricity, the report noted, was well established in many homes.

The Seattle Electric Company's headquarters in the Electric Building on Seventh and Olive featured for a number of years a unique display of domestic electrical devices known as "The House Without a Chimney." This five room model "flat" exhibited a range of available appliances appropriate for use in each room, and clearly portrayed the ultimate in domestic luxury of the period. A 1912 Souvenir Edition of The Electric Journal described the electrical contents of the rooms as follows:

- -- drawing room -- fireplace with luminous radiator, ceiling fixtures, and "artistic applications of electric light to decorations."
- -- kitchen -- range, hot plate, percolator, water heater, tea kettle, combination cooker, frying pan, griddle, toaster oven, broiler, disc stove, egg boiler, and sterilizer.
- -- bathroom -- electric water heater attached to tub, portable luminous radiator, shaving mirror and mug, and vibrator.
- -- bedroom -- reading lamp, sewing machine, warming pad, curling iron, hair dryer, cigar lighter and water heater.

In contrast to electric transportation, domestic and industrial consumption of electricity continued to expand decade after decade. The Seattle Electric Company, followed by Puget Sound Power and Light, competed with the Municipal City Light Department in supplying users. Electric heating remained expensive and experimental until the 1950s. In 1925, for example, only 700 homes in Seattle were using electric heat exclusively. The price was double that of coal, and the average yearly cost for heating a five-room house with electricity was $175/year.

By 1910, electric ranges were on display at the Electric Building in downtown Seattle. The Seattle Lighting Department promoted their use through sales, and by providing maintenance. In 1914, Puget Sound Traction, Power and Light offered free demonstrations in "Electric Cookery -- Practical, Simple, Cheap and Economical." Seattle City Light served approximately 2,500 ranges by 1922. By the end of 1926, that number had increased to 10,556.

Refrigeration by electricity was still in its infancy in Seattle in 1926, and cost was still a major problem. The electric water heater, however, had gained widespread acceptance by 1912. (Seattle City Light Annual Reports, 1912-13, 1922, 1926) A local 1914 advertisement for an "Electric Christmas" featured small appliances from heating pads, to Christmas tree lights, to waffle irons. A 1939 ad demonstrates the growth of major appliances including "water heaters, vacuum cleaners, and other modern household electrical servants." By 1950, Seattle City Light boasted that Seattle used over three times as much electricity as the national average.

Georgetown: The Community

As a community, one of many "streetcar suburbs," Georgetown reflected the increased availability and application of electricity. In 1906, Georgetown was a separate incorporation, known for its political independence, its industrial potential and its "wide open" roadhouses. The settlement was originally the agricultural community of Duwamish, first homesteaded by the familiar names of Holgate, Van Asselt, and Horton. Italian truck gardeners were also among the earliest inhabitants. The town was platted by Julius and Ann Horton, and the name changed to Georgetown after their son George in 1901. Georgetown was incorporated in 1904 and stubbornly held out against annexation by Seattle until 1910, largely owing to the partnership of its leaders with the local brewery and saloon interests. (Peterson, pp. 1-4, 22, 71-77)

Industry was the driving force of Georgetown from an early date. The town grew from a population of 2,500 in 1901 to 7,000 in 1910, largely because of increasing industrial activity. The Denny Clay Company, a major brick manufacturing firm which supplied brick and terra cotta to build much of Seattle, was the first to locate in Georgetown. The Seattle Brewing and Malting Company was established in 1893 and soon became the community's largest and most influential employer. The census of 1900 listed a number of Seattle Electric Company employees -- conductors, brakemen, and switchmen -- as residents of Georgetown where the company car barns and an interurban station were located. The Olympic and the Union iron foundries, furniture manufacturing, and river-related industries were also situated in Georgetown by 1900. (Peterson, pp. 25-27) By 1906, the dredging and straightening of the Duwamish River was planned and its future as a major shipping center already envisioned. Streetcars first arrived in Georgetown in 1882 on the Grant Street line, running open cars over trestles above the tideflats. The Seattle Electric Company extended that line to South Park and brought its car barns to Georgetown at the turn-of-the-century. In 1906, larger car barns were built employing over 200 men, in conjunction with construction of the Georgetown Steamplant. (Pacific Building and Engineering Record, January 13, 1906 and Peterson, pp. 40-41)

In spite of its industrial economic base, Georgetown was also a community of residences, businesses, parks, and institutions. Georgetown was the site of the King County Hospital and Poor Farm. With a large German population, Oktoberfest was a major community festivity. There were many boarding and rooming houses for single male workers, including off-season carnival employees and gypsies. Entertainment in Georgetown was never puritanical. Meadows Race Track was two miles out of town, and roadhouses along the way contributed to a steady stream of joy-riders from Seattle on summer afternoons. Georgetown was a colorful, liveable place to its residents, but the community was under frequent attack by the Seattle press for its liquor laws. On November 3, 1909, the Seattle Times wrote that:

> It is one of the few places in the state where the sale of liquor has been abused and where the whole community has become a by-word

> and a reproach for all that is vile and depraved in the liquor business. (Peterson, pp. 56, 63, 77)

Although the electric car barns were eventually closed, Georgetown remains an industrial community, comfortably mixing a small residential section with much larger industrial plants. It is, like its namesake steamplant, a survivor from a past era of smaller scale and more restricted patterns of transportation. Today, both electricity and electrical users operate on much larger scales, commuting from distant suburbs, and transporting electricity on regional grids. In their heyday, Georgetown and the Georgetown Steamplant were considered leaders in a new electrical way of life. Their survival in the last decades of the twentieth century, remind us all of a national movement into the Electric Age. As an ironic comment on how quickly what seemed paramount so soon became mundane and on how much our dependence on electricity continues to accelerate. The mosaic mural in the central offices of Seattle City Light proclaims its determination to supply electricity "that man may use freely as the air he breathes . . . ."

FOOTNOTES

1. The general history of General Electric's development of the Curtis turbine is discussed in J.W. Hammond, Men and Volts: The Story of General Electric (New York: Lippincott, 1941), pp. 283 ff; E.L. Robinson, "The Steam Turbine in the United States; III--Developments by the General Electric Company," Mechanical Engineering, Volume 59 (1937) pp. 239-256; and most usefully, William Le Roy Emmet, The Autobiography of an Engineer (Albany: Fort Orange Press, 1931), Chapter 8.

2. Curtis was a patent lawyer and entrepreneur in addition to being an engineer. He studied civil engineering at Columbia College, graduating in 1881, and law at the New York Law School, graduating in 1883. After eight years as a patent lawyer, he became involved with the manufacture of electric motors. His first important patents were those for the steam turbines. He went on to obtain the first American patent on a gas turbine, in 1899, and an important patent on diesel engines, in 1930. (A.S.M.E. 1975, pp. 1-3)

3. General Electric did not keep the records of the early sales of Curtis turbines (personal communication, George Wise, Historian, General Electric Company, August 3, 1979) so it is impossible to say who bought them. The figures of the 1907 U.S. Census Special Report on Street and Electric Railways, p. 518, suggest that electric railway companies (who generally also sold electric power to the public) bought most of them:

size	number	power
all	252	535,404 H.P.
less than 500 H.P.	23	3,788
500-1000	70	49,491
1000-2000	51	69,787
over 2000	108	412,338
over 500	23	179,200

   Individual manufacturing companies, producing power for their own factories, were probably the second largest group of purchasers.

4. Unlike early steam engines that varied the pressure of steam to control speed under load, the Curtis turbine used a series or belt of steam nozzles at one or two points around the turbine wheel. The governor directly controlled the number of nozzles open at any one time, thus assuring full pressure at the inlet point, no matter how many or how few nozzles were open. Greater loads on the generator would cause the governor to open more nozzles to maintain

a constant speed. "With such a machine it is possible to operate over at least half the range of the machine with maximum and minimum economy varying not more than five percent from the average." (Parker 1910, p. 78)

5. Stone and Webster Public Service Journal, Volume 1, August 1907, p. 118; September, p. 206; October, p. 272; November, p. 354; Volume 2, January, 1908, p. 535; March, p. 685-6; April, p. 773; and June, p. 950.

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EQUIPMENT INVENTORY (Preliminary)

EQUIPMENT	REMARKS	DATE OF MANUFACTUR OR INSTALLATION
Steam Boilers		
7 Boilers, each rated 369 boiler horsepower, equipped with superheater.	The boilers were originally coal fired, then converted to burn oil starting in 1918. Final conversion to oil was completed in 1946.	1906 & 1918
2 Boilers, each rated 473 boiler horsepower, equipped with superheater.	Babcock & Wilcox manufactured 14 of the boilers for the Seattle Electric Co. in 1906. In 1918 these two boilers were added.	
7 Boilers each rated 519 boiler horsepower. Boilers are not equipped with superheater.	Each Sterling type boiler has lettered cast manhole inspection covers, 12 per boiler. The boilers also have the name "The Seattle Electric Company" across the top.	
Boiler Steam Pressure Gauges		
0-300 psi. (Total of 16)	Manufactured by J. Marsh Co., Chicago, Illinois. These are fancy brass gauges approximately 15 inches in diameter.	1906 & 1918
Boiler Room Panel		
See remarks	Mounted on the panel is an antique brass pressure gauge (1898) manufactured by Wm. H. Birch Co., San Francisco, Calif. Range 0 to 250 psi., 10 inch. The panel also contains: an old Bristol Recorder manufactured by the Bristol Company, Waterbury,	

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
	Conn., a small gauge manufactured by North Coast Engineering Company, Seattle, Wash., and a larger gauge manufactured by J. P. March Co., Chicago, Ill.	
Donkey Boiler		
Boiler Number 3535 Operating pressure 0-160 psig. Oil Fired.	Built for Bucyrus Company, by Johnston Bros., Inc. Ferrysburg, Michigan. The boiler is used for start up.	1924
Induced Draft Fans		
Size 998 Design 2 Fans number 1 & 2, 9 & 10, 13 & 14, 15 & 16 are Model Number 13741. Fans number 3 & 4, 5 & 6, 7 & 8, 11 & 12 are Model Number 13740.	Manufactured by B. F. Sturtevant Company.	ca. 1935
Fuel Oil Storage Tank		
Storage capacity 20,328 barrels.	The storage tank is buried underground.	ca. 1917
Turbo-Generator Number 1		
Curtis Steam Turbine (No. 3007) (4 stage vertical shaft steam turbine).	Manufactured by General Electric Co. Steam Pressure 175 psi.	1907
Alternating Current Generator 3,000 KW Vertical Type ATB No. 148684 Class 10, Volts 13,200, Amps 131.5	Manufactured by General Electric Co. Schenectady, N.Y.	1907

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Turbo-Generator Number 2		
Curtis Steam Turbine (No. 4137) (5 stage vertical shaft steam turbine).	Manufactured by General Electric Co. Steam Pressure 175 psi.	1908
Alternating Current Generator 8,000 KW Vertical Type ATB No. 119566 Class 10, Volts 13,800, Amps 334	Manufactured by General Electric Co., Schenectady, N.Y.	1908
Turbo-Generator Number 3		
Curtis Steam Turbine (No. 13401) (9 stage horizontal shaft steam turbine).	Manufactured by General Electric Co. Steam Pressure 175 psi.	1917
Alternating Current Generator 10,000 KW Horizontal Type ATB-4 Volts 13,800, Amps 524 No. 1181396	Manufactured by General Electric Co., Schenectady, N.Y.	1917
Barometric Condenser No. 1	Manufactured by City Light Used with Unit No. 1.	1969
Barometric Condenser No. 2	Manufactured by Hydraulic Supply Manufacturing Co., Seattle, Wash., Used with Unit No. 2.	1965
Jet Condenser	Manufactured by C. H. Wheeler, This condenser is used with Unit No. 3.	1917

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Weiss Air Pump (Vacuum)		
Number 149 Used with vertical Turbo-Generator Unit No.1.	Built by Southwark Foundry and Machine Co. Patented April 28, 1896 Philadelphia, PA	1907
Weiss Air Pump (Vacuum)		
Number 174 Used with vertical Turbo-Generator Unit No. 2.	Built by Southwark Foundry and Machine Co. Patented April 28, 1896 Philadelphia, PA	1908
Electrical Panels		
Panels are Grey Marble approximately 2 inches thick. There are 27, two piece sections.		ca. 1907 & 1917
The following equipment is panel mounted on these panels.		
1 Western Stanton Volt Meter Number 5746 Range 0-600 Volts	Manufactured by Western Electric Instrument Co., Newark, New Jersey	
Thompson Recording Watthour Range 2000 amp, 600 volt (Total of 4)	The meters appear to be in good condition. All were manufactured by General Electric Company.	
Thompson Astatic Ammeter 1 - Range 0 - 500 amp 1 - Range 0 - 800 amp 1 - Range 0 - 1000 amp 1 - Range 0 - 1300 amp 4 - Range 0 - 1500 amp 1 - Range 0 - 2000 amp	All meters were manufactured by General Electric Company	

EQUIPMENT	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Electric Panels (Continued)		
Miscellaneous Meters Volt meters, Ammeters Watthour meters, Temperature indicators (Total of 50 meters)	The majority of these meters are ammeters, 34 of these. All meters were manufactured by General Electric Company	
Power Factor Meter (Antique) 1 meter	Manufactured by Westinghouse Electric Company.	
Voltage Regulator (Antique) 1 regulator Number 1661	Manufactured by General Electric Company, Schenectady, N.Y., USA.	
Synchronous Meter 1 Meter	Manufactured by Genernal Electric Company.	
Reverse Power Relays 2 Relays (small) 8 Relays (large)	Manufactured by General Electric Company	
Frequency Indicator Frahm System	Manufactured by James G. Biddle Company	
Large Solid Copper Knife Switch 8 total, miscellaneous sizes, multiple blade type.	Manufacturer unknown.	
Two Blade Knife Switch Solid Copper 13 total, misc. sizes	Manufacturer unknown.	
Single Blade Knife Switch Solid Copper 15 total, misc. sizes	Manufacturer unknown.	

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Framed Switch and Fuse Panels		
4 Panels, the panels have two blade knife type switches and use screw-in type fuses.	The panels are for lighting and miscellaneous circuits. Manufacturer unknown.	ca. 1907
Oil Circuit Breakers		
7 Breakers - small 36 Breakers - large	Manufactured by General Electric Company	1907 & 1917
Knife Switches		
More than 50 solid Copper multi blade type switches.	Manufacturer unknown.	1907 & 1917
Transformers		
Bank No. 1 Type WC, 500 KW 13,800 volt (2 transformers in bank)	Manufactured by General Electric Company	ca. 1907
Transformers		
Bank No. 2 13,800 1000 KVA (2 transformers in bank)	Manufactured by Westinghouse Electric Company	1907
Automatic Circuit Breakers (Antique)		
4 Circuit Breakers	Manufactured by General Electric Company	ca. 1907
Lube Oil Pump (Duplex Type)		
Steam Driven, 2 cylinder Size 9 x 3-1/8 x 10 Number 189-977	Manufactured by Worthington	ca. 1907

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Lube Oil Pump (Duplex Type)		
Steam Driven, 2 cylinder Size 9 x 3-18 x 10 Number 190-208	Manufactured by Worthington	ca. 1907
Lube Oil Transfer Pump (Duplex Type)		
Steam Driven, 2 cylinder Size 4-1/2 x 2-3/4 x 4 Number 164828X9	Manufactured by Knowles Pump Works New York, New York.	ca. 1917
Fuel Oil Pumo (Duplex Type)		
Steam Driven, 2 cylinder Reciprocating Type Size (Data not available) 2 identical pumps	Manufactured by (Name plate data missing) Hallidie Machinery Company, Seattle, WA Sales agent.	ca. 1918
Fuel Oil Pump		
Screw Type, Electric Motor Driven Size 4, 250 Head, 80 gal/min Number 867	Manufactured by William E. Quemby, Inc., New York, New York	ca. 1930
Feed Water Pump (East)		
DeLaval Centrifugal Type 140-TC-3P5 650 gal/min 520 Head Number 56980	Manufactured by Ingersoll Rand Co. New York, New York.	ca. 1917
Steam Turbine (for feed pump) 2300 RPM Number 56980	Manufactured by DeLaval Steam Turbine Company, Trenton, New Jersey	ca. 1917

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Feed Water Pump (West)		
Ingersoll Rand Centrifugal 900 gal/min, Size 4GT900 552 Ft. Head Number 06493050	Manufactured by Ingersoll Rand Company, New York, New York.	1949
Steam Turbine (for feed pump) 3600 RPM Serial Number 79336 Model Number 7TDP1117AEK 180 Horsepower	Manufactured by General Electric Company, Schenectady, New York.	1949
Air Comoressor		
Size 8 x B Electric Motor Driven Number 36175	Manufactured by Curtis St. Louis, Mo.	1950
Centrifugal Water Pump		
Spare Pump Small Electric Motor Driven (Name plate date missing.)	Name plate data missing. The Spare pump is not connected into system	ca. 1917
Hot Well Tank		
14 ft. diameter x 12 ft. deep Steel plate construction.	Manufacturer unknown	1917
Fuel Oil Strainer System	Manufactured by Bethlehem Steel	ca. 1930
Step Bearing Lube Oil Tank	Manufactured by Turner Oil Filter Co. Niles, Michigan.	1907
Mid Bearing Lube Oil Tank	"	" 1907
Spare Lube Oil Tank	"	" 1907
Air Pump Lube Oil Tank	"	" 1908

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Ingersoll Rand Air Compressor		
Large unit similar to the unit installed in Lake Union Steam Plant	This unit is dismantled. It will be used for parts for the Lake Union Compressor. In addition there is an Allis Chalmers 125 horsepower induction motor to run this compressor.	
Step Bearing Oil Pump (Duplex)		
Steam driven 2 cylinder Recriprocating Type Size 12 x 2-3/4 x 18 Number 192035 Used on Unit No. 1	Manufactured by Worthington.	1907
Step Bearing Oil Pump (Duplex)		
Steam driven 2 cylinder Recriprocating Type Size 12 x 2-3/4 x 18 Number 192036 Used on Unit No. 2	Manufactured by Worthington	1908
Centrifugal Pump		
Steam driven Size 4 400 gal/minute 560 ft head 2750 RPM	This is a spare pump not connected to plant system. Manufactured by Platt Iron Works Dayton, Ohio	
Turbine Drive Terry Turbine Number 1759 2750 RPM	Manufactured by Terry Steam Turbine Company Hartford, Connecticut	

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTU[RE] OR INSTALLATION
Condenser Pump (Unit No. 3)		
Pump Size 18 D.V.S. Number 06280	The pump may be operated by either electric motor or by steam turbine. Manufactured by Wheeler Condenser Engineering Company	1917
Pump Reduction Gear Drive Number 548	Manufactured by Moore Steam Turbine Corporation.	1917
Turbine Drive Number 3555	Manufactured by Terry Turbine Company.	1917
Pump Electric Motor Drive Number 1648315	Manufacturer General Electric Company	1917
Wheeler Turbo Air Pump (Vacuum)		
Pump Size T-A-100 Number 04968	Manufactured by Wheeler Condenser & Engineering Co., New York, N.Y. The pump is used with condenser number 3 and is steam driven.	1917
Steam Turbine Drive Number 4635	Manufactured by Westinghouse Machine Co., Designers & Builders, East Pittsburgh, Pa.	1917
Overhead Bridge Crane		
Capacity 50 ton Number 715	Manufactured by Northern Engineering Works, Detroit, Mich. This is the main powerhouse crane.	1907
Overhead Bridge Crane		
Capacity 20 ton	Manufactured by Reading Crane & Hoist Works, Reading, Pa. The crane is located in the area over the Motor Generator sets	1907

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
<u>Small Electric Crane</u>		
Capacity 1 ton M 1210 Frame 25	Manufacturer Budget	1955
<u>Step Bearing Oil Pressure Balance Weight Alarm</u>		
Set at 950 psi.	Manufacturer unknown.	1907
<u>Simplex Water Meter</u>		
Meter Scale measures in 100,000 lbs per hour at 70 F.	Manufactured by Simplex Valve and Meter Company, Philadelphia, Pa. This meter is a valuable antique.	1907
<u>Per Cent Carbon Dioxide (CO_2) Wall Mounted Meter</u>		
0 to 20% Scale Multi Point type	Used to monitor Boiler Combustion, Manufactured by Leeds & Northrup Company, Philadelphia, Pa.	1907
<u>Panels</u>		
The two panels (one for Turbo Generator Number 1 and the other for Turbo Generator Number 2), have solid brass gauges. One gauge for 1st stage pressure, one gauge for Steam Supply pressure, one gauge for step bearing oil pressure, one gauge for vacuum. The panel for Unit Number 1 has a frequency indicator mounted at the top. It may be used to monitor either unit's frequency.	4 Gauges were manufactured by General Electric Company. The frequency indicator was manufactured by James G. Biddle, Philadelphia, Pa.	1907 & 1908

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Panel		
Turbo-generator Unit Number 3 2 brass hydraulic pressure gauges, 0-2000 psi.	Ashcraft	1917
1 Brass steam gauge, 0-260 psi. . . .	Syracuse Gauge	1917
1 Aston Brass Gauge	Aston	1917
Telephones (Antique)		
Hand crank type.	There are 4 or more units, one located in the pump house and at least 3 located in the plant. Manufacturer unknown	
Fuel Oil Transfer Pump (Duplex)		
2 Cylinder reciprocating type Electric Motor Driven	Manufactured by Fairbanks Morse Company. (ca. 1910) Brought in from Lake Union Plant	1953
Motor Generator Set No. 2		
Continuous current Generator No. 159471 Type MP Class 8-500-514 Form H Amperes - 833 Speed - 514 RPM Volts 600	Manufactured by General Electric Company, Schenectady, N.Y.	1907
Snychronous Motor Number 161143 Type ATI Class 14-530-514 Form C H Power - 700	Manufactured by General Electric Company, Schenectady, N.Y. Approx. ~~Mfg. 1906~~	1907

EQUIPMENT	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
<u>Motor Generator Set No. 2</u> (Continued) Speed 514 Volts 13,200 Amp 28,8 Cycles 60		
<u>Exciter No. 2</u>		
Motor Generator Set Continuous Current Generator Number 140447 Form B KW-120 Amperes 960 Speed 600 Volts 125	Manufactured by General Electric Company, Schenectady, N.Y. Approx. Manufacture 1906	1907
Induction Motor Model No. 14070 Type 10-17-12-175-600 Form K Volts 280 Amps 40 Number 161679 HP 75 Speed 580 2 Phase	Manufactured by General Electric Company, Schenectady, N.Y. Approx. Manufacture 1906	1907
<u>Direct Current Generator</u>		
No. 1201823 Type MPC - 6-200-1200 Form L Amps 1600 Volts 125 Speed 1200 RPM [illegible] KW Nominal	Manufactured by General Electric Co., Schenectady, N.Y.	1917

EQUIPMENT	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Direct Current Generator (Continued)		
Steam Turbine Drive Number 56684 Speed 3600 RPM Steam Pressure 200 psig With DeLaval Speed Reducer	Manufactured by DeLaval Steam Turbine Co., Trenton, N.Y.	1917
Exciter No. 1		
Generator No 78345 Volts 120 Amperes 125 RPM 1130	Manufactured by Allis Chalmers Company, Milwaukee, Wis.	1907
Electric Motor Number 78346 HP 22.5 Volts 220 Amps 55 3 Phase Frequency 60 H_z RPM 11,300	Manufactured by Allis Chalmers Company, Milwaukee, Wis.	1907
River Pumps		
20" Size 13,500 Gallons per Minute 85 Feet Head 690 RPM Type S Pump #1, Style A, Serial No. 1498 Pump #2, Style B, Serial No. 1497	The two pumps are in the pumphouse located on the Duwamish River. The pumps were manufactured by Allis Chalmers. The pumps are each driven by a 400 HP electric motor. The motors are type IQ, Form K, 2200 volt, 2 phase, manufactured by General Electric Company.	ca. 1935
Floor Mounted Drill Press		
Antique, Belt Driven Type	Manufactured by Champion Company.	ca. 1907

EQUIPMENT (Continued)	REMARKS	DATE OF MANUFACTURE OR INSTALLATION
Bristol Recorders		
Panel mounted Antique type (vacuum gauge)	Manufactured by Bristol Company, Waterbury, Conn.	ca. 1907 & 1918
Large Master Gauge		
Approx. 2 feet in diameter Range 150 to 210 psi. Brass construction	Manufactured by Ashton. This is an antique	1906
Air Raid Siren		
World War II model Roof Mounted Engine Driven	Engine manufactured by Chrysler. Siren manufactured by American Blower Co.	ca. 1941

ADDENDUM TO
GEORGETOWN STEAM PLANT
King County Airport
Seattle
King County
Washington

HAER No. WA-1

XEROGRAPHIC COPIES OF COLOR TRANSPARENCIES

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
1849 C. St. NW
Washington, DC 20240